International Civil Aviation Organization

TWELFTH MEETING OF THE SOUTH EAST ASIA AND BAY OF BENGAL SUB-REGIONAL ADS-B IMPLEMENTAITON WORKING GROUP (SEA/BOB ADS-B WG/12)

Guangzhou, China, 08 – 10 November 2016

Agenda Item 7: Any other business

USE OF ADS-B UNDER RADAR ENVIRONMENT

(Presented by Singapore)

SUMMARY

This paper shares with the Working Group the progress made by Singapore on the use of ADS-B under the radar environment.

1. Introduction

1.1 The Civil Aviation Authority of Singapore (CAAS) planned to use the ADS-B data from Singapore and those from the neighbouring States sharing ADS-B data with Singapore, for air traffic services (ATS) within the entire Singapore FIR.

1.2 As part of the safety management process, a safety case is required to assure the regulators that the use of ADS-B data for the ATS operations is sufficiently safe.

2. Challenges on the ADS-B Safety Case

2.1 When CAAS first worked on the safety case, the plan was to cater for the entire Singapore FIR, regardless whether the area is under radar or not. The main guidance documents used were the ICAO Cir326, EUROCAE ED-126 and EUROCAE ED-161.

2.2 According to ICAO Cir 326, there is no difference between the ADS-B applications in radar and non-radar environments. There is also no mention on the difference on whether the avionics should be of version 0 (i.e. RTCA DO-260), version 1 (i.e. RTCA DO-260A) or version 2 (i.e. RTCA DO-260B). But there was a mention in Cir326 that States have to do their own technical assessment when using ADS-B in complex environment (which is usually radar environment).

2.3 According to EUROCAE ED-161, only version 1 and 2 avionics (i.e. RTCA DO-260A and DO-260B) are assessed to be able to support ADS-B in radar environment. In the EUROCAE ED-161, there is a statement saying that States who want to use ADS-B data from version 0 avionics in radar environment will have to perform their own technical assessment. As most of the existing aircraft are equipped with version 0 avionics, Singapore has delayed the use of ADS-B within radar environment until the additional assessment is performed.

2.4 According to EUROCAE ED-126, ADS-B may be used under non-radar environment, regardless whether the ADS-B avionics are versions 0, 1 or 2. CAAS hence relied on EUROCAE ED-126 and ICAO Cir326 to complete its safety case for ADS-B application under the non-radar environment of the Singapore FIR. The radar range, hence the 'radar environment' is shown in the diagram below.

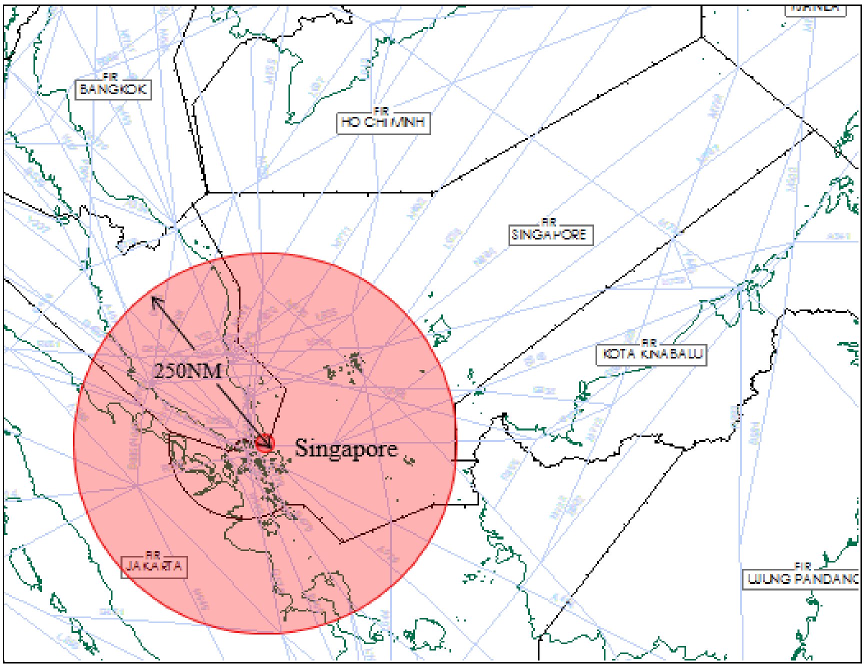

Figure 1: Long range radar coverage

2.5 Following the completion of the safety case for ADS-B application under non-radar environment, CAAS commenced ADS-B operations at parts of its non-radar area (i.e. the designated ADS-B airspace) on 12 Dec 2013. Subsequently, CAAS continued to work on ADS-B application under radar environment, which required technical assessment.

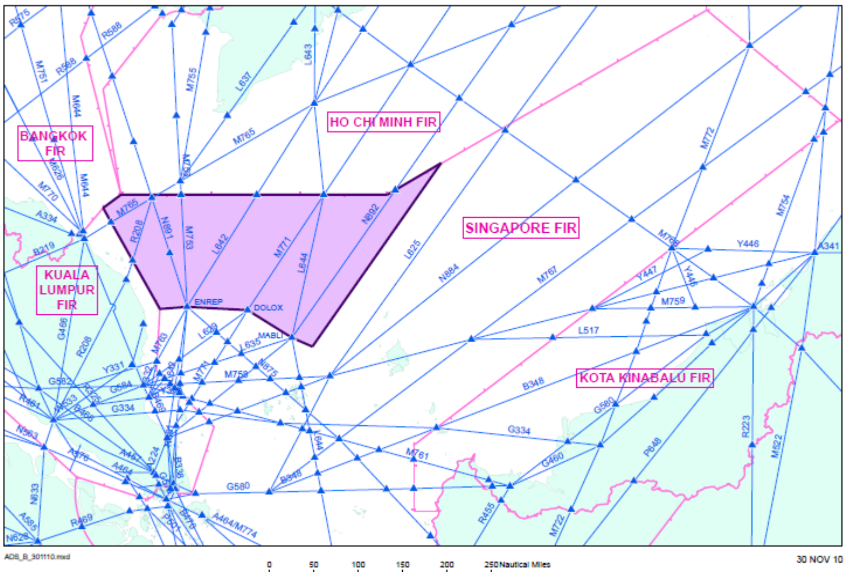

Figure 2: Designated ADS-B airspace

3. **Assessment on ADS-B under radar environment**

Track stability

3.1 CAAS worked with MITRE Asia Pacific Singapore (MAPS) to perform the assessment on the use of ADS-B together with radar.

3.2 MITRE obtained three months of the surveillance data from CAAS to examine the effects of ADS-B data on the quality of fused tracks, i.e. Multi-Sensor (MS) vs Multi-Radar (MR) tracks. Based on statistical analysis and visual examination, it was found that the MS tracks (which includes the fused ADS-B data) is more accurate and stable than the available MR tracks (which only include radar data).

3.3 The above demonstrated that the MS tracks is 'not worse-off' than MR tracks.

Hazard Analysis

3.4 The main hazards to be considered are the loss of ADS-B tracks and incorrect ADS-B tracks.

3.5 In the event of a sudden loss of ADS-B tracks, controllers can still rely on radars for air traffic control, which is the current mode of operation. In the event of incorrect ADS-B tracks (e.g. B787 problem), various safety net alerts such as split tracks or duplicate identity (the incorrect ADS-B tracks split from the radar track but carrying the same identity) alert and Route Adherent Monitoring, are available in the Air Traffic Management system to warn the controllers and controllers will then take appropriate actions similar to those under the current radar environment. At the same time, CAAS will take pro-active actions to contact airlines with aircraft transmitting misleading ADS-B data for rectification, if any is found.

3.6 Based on the above, it is shown that the integration of ADS-B into the radar environment hardly introduces additional risks.

Other considerations

3.7 The data analysis also revealed the following:

a) 96% of the flights are equipped with ADS-B avionics and detected by the ADS-B stations used by CAAS;

b) 99% of the ADS-B data has NUC of 5 and above;

c) 90% of the data has update rates 3s or less, which is significantly better than the individual radars (e.g. 4s for approach surveillance radars).

3.8 Factors that can improve the quality of to the MS tracks include: 1) most of the flights operating in a given airspace are equipped with ADS-B; and 2) the ADS-B data have sufficiently high NUC values (i.e. NUC $\geq$ 5). These are met by points 'a' and 'b' in para 3.7. For ADS-B to effectively influence and improve track accuracy and stability, the update rate has to be sufficiently high, preferably higher than radars. This is met by point 'c' of para 3.7.

4. Commencement of use and limitations

4.1 With the positive results of the technical assessment, CAAS commenced the use of ADS-B under the radar environment with effect from 22 August 2016, 0001 UTC. The benefits brought to the controllers are:

a) faster identification of tracks during take-off;

b) less coasting of tracks as ADS-B bridges some of the ‘radar gaps’.

4.2 There are, however, also limitations. Other than the designated ADS-B airspace, where controllers use the ‘ADS-B only mode’ for air traffic control, controllers can only apply radar separation when the MS track is contributed by at least one radar. That means, in the event of total radar failure or in large radar gaps, controllers still have to apply procedural separation for the time being until further study proving that radar separation can continue in such scenarios.

5. Future study

5.1 In future, CAAS will study the possibility of using of ADS-B for radar-like separation between ADS-B equipped aircraft, instead of procedural separation, in the event of total radar failure or in large radar gaps. This will include the scenarios before and after all aircraft are equipped with ADS-B, which may involve mandatory ADS-B equipage in a large portion of the radar airspace.

6. Conclusion

6.1 The meeting is invited to:

a) note the progress of Singapore on the use of ADS-B under radar environment;

b) discuss the content of the paper.

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